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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 38.

B. T. GALLOWAY, *Chief of Bureau.*

12080

FORAGE CONDITIONS AND PROBLEMS IN EASTERN WASHINGTON, EASTERN OREGON, NORTHEASTERN CALIFORNIA, AND NORTHWESTERN NEVADA.

BY

DAVID GRIFFITHS,

ASSISTANT IN CHARGE OF RANGE INVESTIGATIONS.

GRASS AND FORAGE PLANT INVESTIGATIONS.

ISSUED JULY 3, 1903.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1903.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

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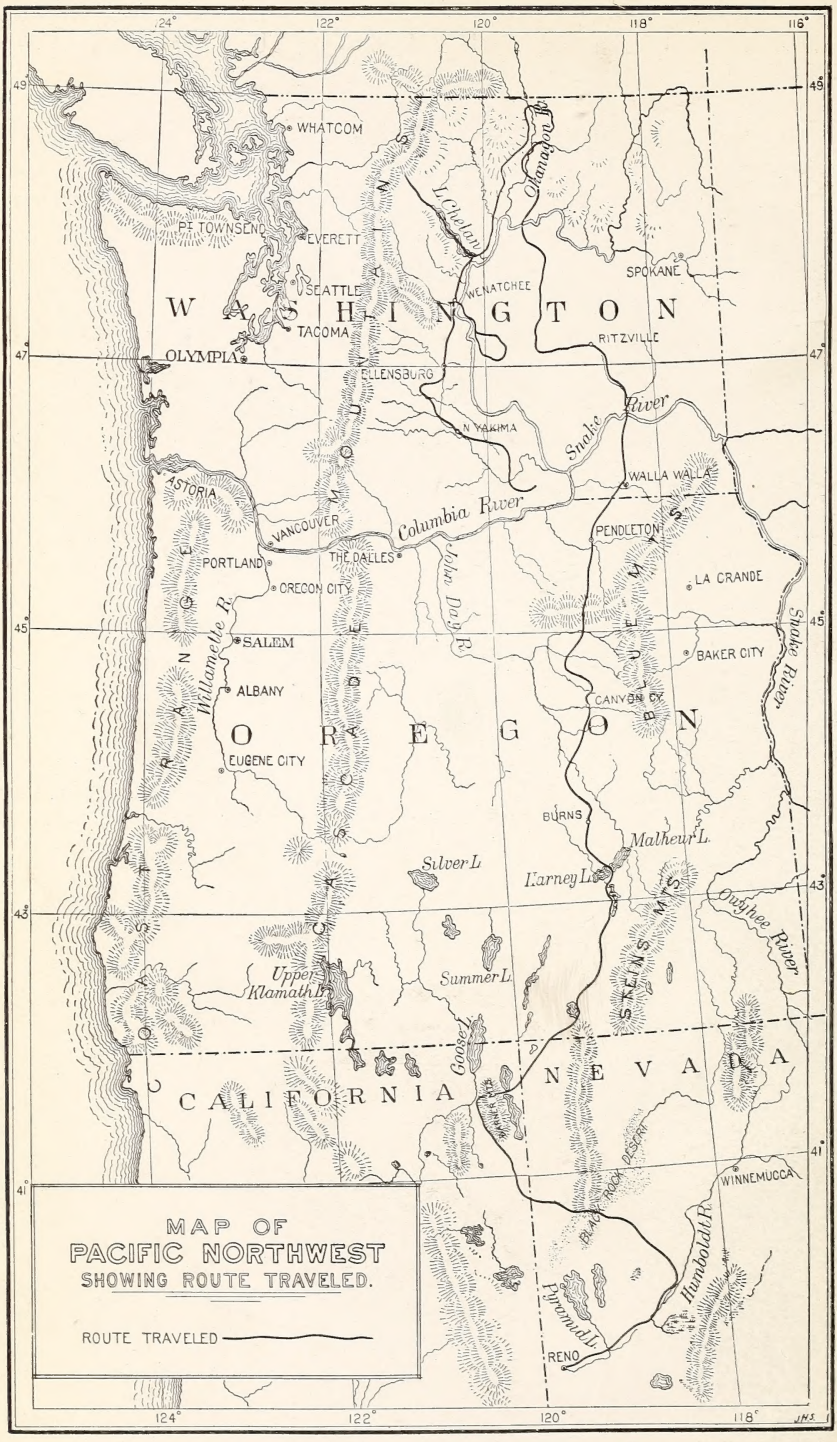

MAP OF
PACIFIC NORTHWEST
SHOWING ROUTE TRAVELED.

ROUTE TRAVELED

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 38.

B. T. GALLOWAY, *Chief of Bureau.*

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GOVERNMENT PRINTING OFFICE.

1903.

BUREAU OF PLANT INDUSTRY.

BEVERLY T. GALLOWAY, *Chief of Bureau.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 17, 1903.

Sir: I have the honor to transmit herewith a report upon "Forage Conditions and Problems in Eastern Washington, Eastern Oregon, Northeastern California, and Northwestern Nevada," and respectfully recommend that it be published as Bulletin No. 38 of the series of this Bureau.

This paper was prepared by Dr. David Griffiths, Assistant in Charge of Range Investigations, Grass and Forage Plant Investigations, and has been submitted by the Agrostologist with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

This is the third paper in the series prepared by Dr. Griffiths bearing on the general subject of range management, two previous reports having been published as Bulletins of the Bureau of Plant Industry, Nos. 4 and 15. The present report discusses existing conditions on the ranges of eastern Washington, eastern Oregon, northeastern California, and northwestern Nevada, points out the causes which have led to the present depleted condition of most of the range country, and suggests needful changes in present methods of utilizing the scanty feed to be found on most of the nonarable lands of the West.

It is noteworthy that the one factor which has contributed more than any other to the depletion of the ranges is the development of hay production on irrigated land in the range region. As long as stock was compelled to subsist the year round on the range, the limited supply of winter feed rendered it impossible to support enough stock to make serious inroads on the more abundant summer growth. The forage plants of the ranges were thus permitted to make seed. But with the advent of hay for winter feed the amount of stock that could be handled increased till in many places the summer growth on the range was entirely consumed, leaving no chance for the production of seed. As a result many thousands of acres of land that formerly furnished abundant pasture are now devoid of any growth that stock will eat, while plants of no value and which are not disturbed by the grazing stock have spread rapidly over these areas.

It is clear that suggestions for the improvement of range conditions to be of value must come from those who are not only familiar with the condition of the ranges, but who also understand the conditions under which stock must be handled on the range. In obtaining the material used in preparing this paper, Dr. Griffiths has traveled 1,700 miles in the range country, mostly by wagon, but no small part of this distance has been covered afoot. On this journey every stockman on the route was interviewed, and in this way much valuable information was collected.

Acknowledgments are tendered to Mr. J. S. Cotton, of the Washington State Experiment Station, who accompanied Dr. Griffiths in his travels over the ranges in that State, and to Prof. Byron Hunter, of the Idaho State Normal School, who rendered similar service in Oregon and Nevada.

W. J. SPILLMAN,
Agrostologist.

OFFICE OF THE AGROSTOLOGIST.
Washington, D. C., March 8, 1903.

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FORAGE CONDITIONS AND PROBLEMS IN EASTERN WASHINGTON, EASTERN OREGON, NORTHEASTERN CALIFORNIA, AND NORTHWESTERN NEVADA.

INTRODUCTION.

This report, based upon field work done in 1902, is in large part supplementary to that of 1901. The investigations of this year have been confined to the same general drainage regions, but the amount of travel performed and the consequent opportunity for study have been much more extensive. All the work covered in this report, as well as in that of last year,[a] was done in two of the great inland regions, namely, the drainage area of the Columbia River and that of the Great Basin. Last year's report covered but little of the former area, being confined mainly to that portion of the Great Basin region lying between Winnemucca, Nev., and the Blue Mountains of Oregon in the vicinity of the upper portion of the Silvies River, while this report deals with the Columbia drainage area and that portion of the Great Basin lying to the westward of the region discussed in the report of last year. The only place where the same area was covered both seasons is in the vicinity of Burns, Oregon. This duplication of region traversed was occasioned by the necessity of obtaining supplies and the desire of visiting again certain portions of Harney Valley which it was impossible to examine last year. Here, in the vicinity of the Dunder and Blitzen River, on the west side of Steins Mountains, many substantial and extensive improvements are being made, especially by the French-Glenn Live Stock Company, in the handling of the native ranges, as well as in the reclamation of the extensive swamp lands, producing at the present time nothing but tules, but which are being converted into hay and pasture lands.

Our traveling outfit consisted of a team, light spring wagon, and an ordinary camping outfit. On the entire trip, wherever possible, we endeavored to drive about 30 miles per day and to accomplish this in the morning, taking the afternoon to make collections, for studies, and for other work, while our horses, which were obliged to pick

[a] Bulletin No. 15, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1902.

their roughage, were feeding. This, together with the work done from the wagon and an occasional stop of a day or a week in certain important localities, enabled us to gain the desired information and at the same time to cover a large amount of territory. Our plans, of course, had to be modified very materially when crossing some of the deserts in July and August on account of the scarcity of water. Here it was necessary to drive from one watering place to another in the shortest time possible.

Traveling a large part of the time over unfrequented roads, with the exception of about 200 miles in range country, it was possible to do a great deal of work from the wagon, making frequent stops as occasion seemed to demand. This was especially true of our trip through the Blue Mountains of Oregon and the Warner Mountains of California, where we were without any well-defined roads for a good part of the way.

ITINERARY.

After spending two days at Prosser, Wash., and taking a short trip into the "Horse Heaven" country, we started northward (Pl. I), having as our destination the Okanogan region, in the northern part of the State. This we reached by way of North Yakima, Ellensburg, Wenatchee, Chelan, Conconully, and Loomis. On this portion of the trip we were on the west side of the Columbia and Okanogan rivers, in a region the greater part of which may be said to represent the dividing line between the summer and the winter grazing grounds. Frequent stops were made along this route, the longer ones in the Kittitas Valley, near Ellensburg, and at Wenatchee and Loomis. From Chelan a four days' trip was taken to Stehekin, and from Wenatchee a similar one into the Big Bend country at Trinidad. The northern limit of the trip was at a point on the Okanogan River about 8 miles from the British border.

On the return trip most of our time for the entire distance to Conden's Ferry was spent on the Colville Indian Reservation. From Conden's Ferry, on the Columbia River, we crossed over the High Plateau of the Big Bend to Steamboat Rock in the Grand Coulee, which we followed as far as Coulee City; thence southward to the west side of Moses Lake, and thence eastward to Ritzville, in the center of the well-developed wheat region. From Ritzville we went southward along Cow Creek, crossing Snake River at the mouth of the Palouse, and thence via Prescott to Walla Walla.

On July 5 we started southward via Pendleton into the Blue Mountains of Oregon. Here we traversed the forks of the John Day River, passing en route through Camas Prairie, Long Creek, Fox Valley, John Day, Canyon City, Izee, Bear Valley, and Silvies Valley, and reaching Burns on July 17. From Burns our route passed between

Malheur and Harney lakes, and thence southward along the Dunder and Blitzen River to the base of Steins Mountains. From this point we went southwest across Catlow and Guano valleys and across the northwestern corner of Nevada into the Warner Mountains of California; thence southward to Smoke Creek and eastward into Nevada again, across the deserts of Smoke Creek and Black Rock, and thence southward into the Humboldt Valley near Lovelock. Our next trip of 100 miles was in a general southwesterly direction to Reno, where the work for the season in this region was discontinued.

GENERAL ACCOUNT.

The region indicated in the map (Pl. I) is one of great diversity of climate, elevation, and soil conditions, and a complete account of these features is therefore obviously impossible in such a publication as this. In brief it may be stated that the areas of greatest humidity are located in the Okanogan region and in the Wenatchee, Blue, and Warner mountains. The best grazing areas of the Okanogan region are at an altitude of 1,500 to 2,500 feet; in the Big Bend of the Columbia, 1,000 to 1,500 feet; in the prairies of the Blue Mountains of Oregon and the Warner mountains of California, 4,500 to 6,000 feet, and in the general desert basins of Nevada and Oregon, about 4,000 feet. The annual precipitation of the region in general may be accepted as 5 to 10 inches, but of course there is a great variation in the mountains and in the vicinity of our route from Ellensburg to the British border. Accurate data regarding higher and less accessible localities are, however, very scarce, and it can only be said that in portions of the region the rainfall is much greater than the above figures indicate.

The soils are, for the greater part, basaltic, i. e., derived from disintegrated volcanic rock, and are usually spoken of, especially in the northern half of the region, as volcanic ash. This may be taken to represent the entire Big Bend country, as well as the greater part of the deserts of Oregon and Nevada visited. The Blue and the Warner mountains, as well as portions of the Okanogan "Bunch-Grass Hills," are of stiff, heavy clays which support a different vegetation as well as one which is less susceptible of injury from tramping of stock than the looser ashy soils of the drier and usually lower regions represented by the desert plains and the fertile lands of the Big Bend. In the lower portions of all the basins, as well as in the poorly drained areas along the river bottoms, are situated intensely alkaline stretches; these are especially characteristic of the region traversed between the Blue Mountains of Oregon and Reno, Nev. These areas in this region support no vegetation whatever over extensive tracts and are known locally as "sleek deserts." They are the remains of old or temporary lakes, which receive constant accretions of soluble salts from the

basins in which they are situated. They are of themselves of no economic importance for, supporting no vegetation and having no outlets in ordinary times, they can not be profitably drained and deprived of the superabundance of soluble salts. They have an immediate connection, however, with the lands in their drainage basins which are being rapidly reclaimed, as will be shown later.

The topography of the Okanogan country differs from that of the Big Bend mainly in being cut up into rolling grassy hills, which are covered with forests of yellow pine on their shaded and higher slopes. The level ground is comparatively small in extent, and when it occurs on elevated regions, as is the case in large stretches on the Colville Reservation north of Conden's Ferry, it is very likely to be too rocky for cultivation; however, in many places in the so-called "Bunch-Grass Hills" there are areas of arable lands, and along all the waterways, especially the main Okanogan River, there are extensive tracts of good hay land yet to be brought under control.

The Big Bend, although a much more level area, still presents a great diversity of topographical features. It may be briefly described as a table-land, 1,000 to 1,500 feet high, underlaid by basaltic rock. This general plateau has been cut in various places by deep gorges, such as the bed of the Columbia, Grand, Moses, and Black Rock coulees, exposing bluffs of basaltic columns, which are a familiar and attractive sight in all of this region. In many places, usually in close proximity to these gorges and especially in the vicinity of such depressions as Moses Lake, the rock is laid bare, or nearly so, over very extensive areas. These must remain permanent grazing grounds. They are known locally as "scab lands," and are usually cut into shallow ravines, being generally much rougher than those areas where the soil is deeper. The irregularity of the erosive action has resulted in the formation of numerous basin-like depressions, where water accumulates and remains for short periods, especially during the winter and spring, thereby furnishing supplies for range stock at those seasons of the year.

The Blue Mountains of Oregon and the Warner Mountains of California have much in common. They are generally forested, but have at high elevations extensive areas of level or gently rolling lands, either free from timber or only sparsely covered. In these areas, usually designated as prairies or valleys, are found the nuclei of prosperous communities. Among these may be mentioned Camas Prairie, Long Creek, Bear Valley, and Silvies Valley in the Blue Mountains, and Jess Valley in the Warner Mountains. These communities are dependent almost entirely upon the stock industry for their support. The lands in these regions are either fertile mountain soils or rocky areas not susceptible of cultivation. The latter furnish pasturage. The former are cropped, usually with hay crops.

The desert region, which occupies practically all of the area between the Blue Mountains and Reno, Nev., except the Warner Range and the Humboldt and Truckee River bottoms, is, in popular parlance, a huge sagebrush plain, broken by numerous low mountain ranges having little or no timber. Between these mountains are the desert sinks and "sleek deserts" previously mentioned. All except the "sleek deserts" are covered with a shrubby growth of sage, saltbushes, and greasewood, which are often the only vegetation.

As compared with the ranges of the Plains, this region generally presents many striking differences. Here there is never a sod except in very favorable localities along streams, where the sedges and native clovers abound. The grasses are truly bunch grasses, although of many botanical species, and the bunches are invariably separated by intervals of a few inches to several feet. With the exception of comparatively small areas of the more fertile regions of the Big Bend and the high mountains, the entire region is covered with a shrubby growth, which is popularly known as sagebrush. There is a great difference here in the soil texture also, it being much looser and less subject to the erosive action of torrential showers. The great difference from the standpoint of the stockman is the entire absence here of the buffalo grass and the blue grama, which are such important factors in the make-up of the Plains vegetation. When compared with the desert regions of the Southwest, we find a greater similarity, especially in the possession of shrubby vegetation, although this shrubbery assumes in the latter more of a thorny and spiny nature and belongs to a very different class of vegetation botanically. In the Southwest is found a class of grasses resembling more closely those of the Plains region, namely, the gramas, which are not only closely related but often identical with the species which is of such importance on the Plains. In regard to the soil, the southwestern stock ranges resemble more nearly those of the Plains as far as the erosive action of water is concerned, although their mechanical and chemical constitution may be very different. As regards the sod, the region in question closely resembles the Southwest, although the latter resembles the Plains region in the species of grasses which it contains. This fact is probably to be correlated with the meteorological conditions mainly, the sparseness and the bunched character of the vegetation between the Rocky and the Sierra Nevada mountains being brought about more by the limited rainfall than by any other cause. This view appears to be strengthened by the fact that many of the grasses of this general region form a close and compact soil cover when grown under the more humid conditions of the Eastern States. The bunching of the grasses, therefore, is probably to be accounted for by the scarcity of the water supply rather than the inherent characteristics of the grasses themselves.

CHANGES IN THE HANDLING OF THE WASHINGTON RANGES.

During the past few years there has been great progress toward a more systematic handling and at the same time a more stable and permanent adjustment of the stock industry in the region of the Big Bend and the country adjacent to it. In many particulars the changes are radical, and in some instances the industry has been remarkably curtailed, though probably not permanently, for the reduced area devoted to the raising of live stock will doubtless be made, when the new conditions become adjusted, to support proportionally a much larger number of animals than it formerly did.

One of the greatest factors in the production of these changes has been the extension of the wheat areas to include practically all of the tillable land of the entire region, apparently regardless of the rainfall. Large areas west of Ritzville, near Trinidad and Waterville, and in the "Horse Heaven" country have in recent years been reclaimed for wheat culture. Some of these areas may not be permanently occupied by wheat, since the average annual rainfall on some of them is less than 10 inches, and some of the more conservative farmers think they will eventually revert to the range.

But the most important factor in these changes has been the agitation brought about in recent years in favor of the passage of a lease law by the National Congress. This agitation, though it has not crystallized into any definite action, has induced many of the nomadic sheepmen, who heretofore owned no land, to invest in lands in anticipation of the enactment of lease laws, which, in all bills thus far introduced, give preference to the actual holders of landed interests. The presence of large areas of railroad land in this region has enabled many to secure from the transportation companies, by lease or purchase (usually the latter), tracts of land suited to their needs. Of course much of this purchase is purely speculative, but a very large proportion of the land so acquired has been bought by those who are and have been for years in the stock business on the public domain. As the railroad land consists of alternate sections, the ownership of these tracts virtually gives the investor control of the adjacent sections of the public domain. As is well known, our homestead laws do not adequately meet the necessities of the man who proposes to embark in the stock business in the semiarid regions, particularly where the railroads own alternate sections. Even a whole section of land is too small a unit for range operations, so that a homestead can only be used as a base for a stock range in cases where all the surrounding lands are a part of the public domain. Indeed, the farmer who raises wheat in this region needs more land to obtain a reasonable compensation for his labor than he can secure under our land laws. In recent years most of the land within the railroad grant has been brought under individual control,

and the open-range question is here practically a thing of the past. The greater part of this area is still unfenced, and the boundaries of the different possessions are only approximately maintained, but much of the land is being fenced, section by section, which permits systematic pasturing. This change has yielded results far beyond the expectations of the ranchers.

In one case which came under observation it was estimated by a rancher that the land under his control had increased in grazing capacity about 50 per cent during the past two years, with no decrease in the number of cattle carried on the entire area. One section is pastured at a time, and grass is allowed to attain considerable growth before being pastured, instead of being grazed close to the ground all the time.

In another instance in the same vicinity a year's rest of two and a half sections of pasture land had yielded marvelous results. This land had formerly been grazed by sheep, and the pasture had become so short that the owner disposed of it to the present occupant, who proposed to embark in the cattle business. He allowed his land to rest one year with practically no stock upon it; the gain in feed was remarkable.

Much of this land is used as winter ranges for sheep, which are either herded during the summer months in the mountains to the westward or pastured on the fallow lands in the wheat-growing regions to the east. This treatment will probably increase the capacity of these ranges to a maximum in a few years, provided the summer season of rest is sufficiently prolonged. It is very important in handling these lands as winter pastures not to keep stock on them too late in the spring. In this region the growth of vegetation occurs only in the spring, and stock are sometimes unable, on account of snow, to get into the mountains soon enough to allow much recuperation after the season of grazing before the advent of the dry season, which begins not later than June.

CONDITION AND PLANTS OF THE RANGE.

The best range seen on the entire trip, and indeed the best open range the writer has seen since the early nineties (with the possible exception of the Clear Creek region in the Big Horn Mountains of Wyoming in 1898), was that of the Okanogan hills in northern Washington. The generally good condition of the feed in this region is due to the fact that the country for various reasons has not been overstocked. A large part of this area is occupied by the Colville Indian Reservation, and some of the lands along the river are taken up by Indian allotments which have not been improved to their full capacity for hay production. The length of the winters, the heavy snowfall,

and the comparative inaccessibility of the region have all contributed to its protection in the past. It is essentially a summer range, and all stock wintered here must be fed for much longer periods than in the warmer and drier regions to the southward. Up to a year ago summer grazing had been practically confined to stock owned by actual settlers, who have not been able thus far to raise sufficient winter feed to support enough cattle to overstock the summer pastures. Doubtless a very important factor in the preservation of the range has been the persistency with which the settlers have prevented sheep from entering the territory. The development of the river bottoms into meadows which will furnish large quantities of hay and the advent of large numbers of sheep during the past summer will no doubt change the appearance of the native pastures very materially in the next few years.

The main forage plants on the ranges in the Okanogan region do not differ materially from those to the southward in the Big Bend except in the relative quantity of feed produced by the different species. The rolling hills are covered with a luxuriant growth of sheep fescue (*Festuca ovina*), bunch wheat grass (*Agropyron spicatum*), Wheeler's bluegrass (*Poa wheeleri*), and Sandberg's bluegrass (*Poa sandbergii*) on the more rocky and gravelly soil. Nevada bluegrass (*Poa nevadensis*) and prairie June grass (*Koeleria cristata*) are also important factors everywhere above the river bottoms, while giant rye grass (*Elymus condensatus*) occurs in large patches along the sides of depressions on broad, level upland areas, as well as on the edges of the more moist lands along the river bottoms. Along ravines and sandy creeks and river bottoms, bunch wheat grass and giant rye grass are prominent in the lower altitudes, but the bulk of the forage is made up of the needle grasses (*Stipa williamsii* and *S. columbiana*), with the introduced weedy brome grasses (*Bromus tectorum*) and chess (*Bromus secalinus*) in the lower draws and benches, where the native grasses have been injured by the trampling of stock on their way to and from feeding grounds and water. On all of the lower sandy benches just above the river bottoms, especially those of the Okanogan and Columbia rivers, the feed is naturally poor, as would be inferred from the presence of the needle grasses and the bromes previously mentioned. Occasionally the stiffer soils are found on these benches, and bunch wheat grass (*Agropyron spicatum*) is always found in such situations, adding very materially to the feed; but in general these benches are taken up by species of rather inferior quality. Here also are found large areas of plantain (*Plantago purshii*), which closely resembles the Indian wheat (*P. fastigiata*) of the Southwest, but is of much less value, probably owing to the fact that feed is more plentiful here and stock are not forced to subsist upon it. Two other

annuals (*Festuca microstachya* and *F. octoflora*) of less value are found on these benches especially, but are also scattered more or less throughout the region.

At the present time the forage plants other than grasses are of little consequence. As sheep are introduced the shrubbery and weedy plants will be utilized to a greater extent, as they are elsewhere in open-range regions; even the clovers appear to be of little consequence here. It must be stated, however, that the observations were made entirely too early in the season to estimate the value of this class of vegetation. Even in the Kittitas Valley and the Wenatchee Mountains, where these plants are of considerable importance, both as hay and pasture, the season was not far enough advanced to enable one to judge of their value. The black sunflower (*Wyethia amplexicaulis*), balsam root (*Balsamorrhiza sagittata* and *B. careyana*) are utilized for pasture to some extent, especially by horses. These plants are of most importance, however, in the region lying to the southwest, especially the Kittitas and Wenas valleys. On the range they are often grazed quite closely by sheep, but all kinds of stock feed on the flower heads and the fruit wherever they are found.

The Big Bend region naturally presents a great diversity of conditions. Some of it is covered with an almost pure growth of bunch wheat grass, while other areas have a mixture of fescues and bluegrasses, and still others have but little grass and are covered with a heavy growth of sagebrush. Part of the area is still open range, while part is systematically handled; consequently this locality presents the greatest diversity in feed conditions. On all the unprotected range visited the feed was very short. The greatest amount of unprotected country seen was in the vicinity of the mouth of the Palouse River, where there was practically no grass, and even plantain (*Plantago purshii*) was extensively grazed in places. Along Cow Creek, however, where the grazing lands are on "scab" between two wheat regions and for the most part are under private control, there was a very evident difference between the open-range and the fenced areas. In that part of the high plateau between the Columbia River and the Grand Coulee which we visited there was excellent feed, owing to the recent invasion of that portion of the country by the wheat grower and the inaccessibility of the remaining range to the general range herds. The grasses here are practically the same as those on the Colville Reservation. Here, however, there is but little shrubbery, the area being a rolling table-land, covered with a luxuriant growth of bunch wheat grass, Nevada and Wheeler's bluegrasses, sheep fescue, and prairie June grass. In places there was some black sage (*Artemisia tridentata*) and rayless golden-rod (*Bigelovia graveolens*) scattered over the lower areas and sides of ravines, but the sagebrush was not

prominent on the high elevations. After reaching the Grand Coulee, however, we were never out of sight of sagebrush until the wheat region west of Ritzville was reached. In many places on the lower, well-drained slopes, there were large patches of giant rye grass (*Elymus condensatus*), while bunch bluegrass (*Poa lævigata*) is of considerable value on the lower portions of the depressions.

The Grand Coulee, which crosses the Big Bend country from north to south, is a deep gorge, 1 to 3 miles wide, and was the bed of the Columbia River during the glacial period. The portions of this coulee visited are in most cases very alkaline. In places there is some seepage from the bluffs which has washed the salt out of the soil over limited areas, and these produce good crops of hay. In the vicinity of the numerous ponds only salt-loving plants are found. In one place was seen a large area, half a section or more, covered with creeping spike rush (*Eleocharis palustris*), which was practically the only forage plant growing in this hay meadow. In the vicinity of the numerous ponds salt grass (*Distychlis spicata*) abounds, and grease wood is always found a little farther from the ponds, while on the better-drained lands the common sagebrush is the most conspicuous vegetation everywhere. The saltbushes (*Atriplex* spp.) are of little account here as compared with the Great Basin region to the south. As would be expected in such a formation and with such physical features, conditions are quite variable. One runs into unexpected areas of grass in pockets in the bluffs where the vegetation is wholly different from anything found for miles around. As an example, might be mentioned a shelf-like recess in the bluffs on the north side of the coulee, where there was an excellent stand of water foxtail (*Alopecurus geniculatus*) covering an area 2 or 3 acres in extent. Usually this grass is not abundant enough to attract much attention anywhere.

On nearly all of the "scab" lands from here south along our route to Trinidad, as well as at other points in the Kittitas and Wenas valleys west of the Columbia River, the black sage of the mountains (*Artemisia arbuscula*) predominates over the common black sage of the lower, more sandy soils. Here also there are large areas of the valuable species of sage known to botanists as *Artemisia rigida*. This differs from the other two closely related species in having finely divided leaves and in being relished by stock, more especially by horses and sheep. It was especially abundant at Trinidad, on the western exposure of the Kittitas Valley, between Ephrata and Moses lakes, and in the vicinity of Lyons Ferry. In all of these localities it showed evidences of being grazed during the past winter.

As far as observed, the areas which have been opened up to wheat culture are not particularly sagebrush lands. On the contrary, they are what is commonly known as bunch grass (*Agropyron spicatum*)

lands, and the shrubbery, when there is any, is mainly the rayless golden-rod (*Bigelovia graveolens*), which is also sometimes called sage. This was the main shrub on nearly all of the wheat lands traversed, especially in the Ritzville and Walla Walla regions. West of Ritzville, however, at the present time wheat ranches are being opened up very rapidly on the sandy sagebrush lands 8 or 10 miles east of Moses Lake. We did not, however, see the establishment of wheat on these sagebrush areas, and it remains to be proved whether the experiments in wheat growing conducted there will be permanently successful.

From the standpoint of quantity, bunch wheat grass (*Agropyron spicatum*) is without doubt the most important grass in the Big Bend region, although the bluegrasses and sheep fescue heretofore mentioned are of much prominence on the higher elevations as well as on the "scab" lands. Owing to the rapid extension of the wheat area, the localities where this grass grows pure are rapidly diminishing in number. It may be said that the form of the grass which is so important here is that designated by botanists as *Agropyron spicatum inerme*, which is so named from the fact that the chaff which incloses the seed is without awns. As one proceeds southward even a short distance into the Blue Mountains, the awned form appears and the awnless one is almost, if not quite, absent.

Attention was called in last year's report[a] to the two forms of sheep fescue in the mountains of Nevada, and it was stated there that they often grow in nearly distinct areas, the glaucous form at higher elevations than the smooth variety. The two forms are found here also; but, although well marked, they have not been observed in separate areas as in the southern desert mountains. As far as forage value is concerned, there is no apparent difference in the two forms.

Although several newly established wheat areas were passed through, there were but two well-established ones on our route. The first extended from about 20 miles west of Ritzville to the "scab" along Cow Creek; the second, from about 8 miles south of Lyons Ferry to Pendleton, Oregon. The developing areas are located at Trinidad, on the high table-land south of Conden's Ferry, and at Ephrata. All the remainder of the territory traveled over in the State is devoted to cattle raising, and all is pasture land except such regions as North Yakima, Wenas, and Kittitas valleys, and small areas in the vicinity of Conconully and Loomis and along creeks emptying into the Columbia River, which are devoted mainly to the culture of hay crops under irrigation.

The poorest "scab" land vegetation is well illustrated by a collection made south of Ephrata, near the Ferguson ranch. The shrubs were by far the most abundant form of vegetation. They consisted

[a] Bulletin No. 15, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1902, p. 52.

of the eriogonums (*Eriogonum dichotomum*, *E. sphærocephalum*, and *E. thymoides*), tetradymia (*Tetradymia canescens*), audibertia (*Audibertia incana*), gilia (*Gilia pungens*), black sage (*Artemisia arbuscula*), and a little *A. rigida*. Of these the eriogonums and *Artemisia rigida* are of economic value. The former are especially useful as a browse for sheep, as undoubtedly nearly all of the species of this genus are when good feed is scarce. The herbaceous vegetation, aside from the grasses, consisted entirely of a scattering growth of *Gayophytum ramosissimum* and *Lygodesmia juncea*, both of which are of some importance as sheep feed. The grasses were few, scattering bunch wheat grass (*Agropyron spicatum*) being the most important, while there was an occasional bunch of needle grass (*Stipa thurberiana*) growing up through the bunches of shrubs. Fescue (*Festuca microstachya*) occurred in very small quantities, and some of the root leaves of Sandberg's bluegrass (*Poa sandbergii*) were in evidence where protected by rocks. It is to be understood, of course, that the above represents the vegetation at the time of observation (July). In the spring there are other short-lived species which furnish some feed. On the better classes of "scab" lands, along Cow Creek and south of Trinidad especially, sheep fescue and the bluegrasses (*Poa nevadensis* and *P. wheeleri*) are more abundant.

The condition of the feed in the Blue Mountains of Oregon was variable, even in areas where meteorological conditions as well as altitude are very similar. This is due entirely to the method of handling the ranges. In the vicinity of the mountain settlements where sheep are excluded the condition of the grazing lands is much better than in the open country. The "dead lines" established by the ranchers, usually on the watershed of the valley, although not always rigidly maintained, have done much to preserve the original vegetation, for it is not as closely eaten off by cattle, a few of which are possessed by every rancher, as by the immense flocks of sheep which are driven into these mountains from all directions. The great stretches of desert range almost surrounding these mountains furnish abundant winter pasturage for sheep, but the summer supply for the growing lambs in the mountains is comparatively limited. The Blue Mountains, therefore, have been the battle ground of conflicting stock interests which have striven for the past twenty years for the major share of the free grass. The homesteader, by protecting small tracts about him, has improved conditions wonderfully in limited areas. But those areas which are not subject to individual control have been so closely pastured that there is no more feed in some localities than on the deserts below. Plate V, figure 1, shows a moist meadow on the north slope of the mountains where there should be, and where there was formerly, a luxuriant growth of grasses, clovers, and sedges, but which is now all but barren of vegetation. A complete collection of the plants

which grew here showed not a single perennial and no annuals over 2 inches in height. These had apparently developed from seed during the previous month, after the sheep had been moved to higher altitudes. The reduction of a sedgy mountain meadow to an almost bare surface, where nothing is to be found but stunted plants of *Navarretia breweri*, *Linanthus harknessii*, knotweed (*Polygonum douglasii*), *Eritrichium californicum*, *Matricaria discoidea*, and burnet (*Poterium annuum*), is a condition much to be deplored, and is certainly not conducive to the best interests of the stock industry. In sheep territory it can be stated that there are few shrubs, aside from the snow brush (*Ceanothus velutinus*) and a few of the phloxes and gilias, in these mountains which are not browsed; and the timber does not grow too thick for sheep to graze in. Even the second growth of pine (*Pinus ponderosa*) is browsed in many places.

The forage plants, especially the grasses, do not differ materially from those of the higher elevations in eastern Washington previously discussed. The conditions are mostly such as would be recognized only by the critical student of grasses. Bluegrasses (*Poa nevadensis*, *P. wheeleri*, *P. sandbergii*, and *P. buckleyana*), sheep fescue (*Festuca ovina* in both its forms), bunch wheat grass (*Agropyron spicatum*), prairie June grass (*Koeleria cristata*), short-awned brome (*Bromus marginatus*), orchard barley (*Sitanion longifolium*), giant rye grass (*Elymus condensatus*), tussock grass (*Deschampsia cæspitosa*), and needle grass (*Stipa viridula* and *S. thurberiana*) are the main species on the open areas, while in upland shady places and in brush and timber areas are to be found a form of Kentucky bluegrass (*Poa pratensis*), downy oat grass (*Trisetum subspicatum*), oat grass (*Danthonia californica*), melic grass (*Melica subulata*), and mountain rye grass (*Elymus glaucus*), together with pine grass (*Carex geyeri*), which constitute the main feed in these localities at an altitude of 4,500 to 6,000 feet. On some of the bare, rocky slopes on the open range occurs some clover (*Trifolium plumosum*). This is seldom so abundant that seed could be collected in quantity. Its strong root system and general habit in barren soils would lead one to believe that it might be of some value on the upland ranges if some method could be devised for its propagation so that seed could be collected advantageously. Along all the creeks and moist areas throughout the region fine feed is produced by other species of native clovers (*Trifolium beckwithii*, *T. cyathiferum*, *T. altissimum*, and *T. involucratum*), while in the same localities there are many species of sedges and rushes which are really of more importance than the grasses in many situations. In these more moist localities are also found mountain timothy (*Phleum alpinum*) and whitetop (*Agrostis asperifolia*).

The numerous pastures in the vicinity of the settlements are used almost entirely for winter grazing, the stock feeding upon the open ranges dur-

ing the summer season. When not pastured too late in the spring, these were in good condition. Very often they appear overstocked, with the result that the weedy plants predominate to a remarkable degree. A collection of plants made in one of these mountain pastures in Camas Prairie will illustrate the effect of too close grazing, especially when the frost is going out of the ground in the spring. This was an open, rocky meadow, with stiff clay soil. There was here originally a good pasture of Sandberg's bluegrass, bunch wheat grass, sheep fescue, Wheeler's bluegrass, Nevada bluegrass, and prairie June grass. These are now very thin and scattering, having been trampled out to a large extent in late May and early June when no stock should have been allowed in the fields on account of their soft and miry condition. The following species were the abundant and conspicuous plants in the pasture: Yarrow (*Achillea millefolium*), black sunflower (*Wyethia amplexicaulis*), arnica (*Arnica alpina*), erigeron (*Erigeron aphanactus*), gaillardia (*Gaillardia aristata*), balsam root (*Balsamorrhiza incana*), lupine (*Lupinus sulphureus*), *Clarkia pulchella*, onion (*Allium madidum*), *Navarretia breweri*, phlox (*Phlox gracilis*), gilia (*Gilia aggregata*), eriogonum (*Eriogonum heracloides*), geum (*Geum trifolium*), *Pentstemon attenuatus*, *Scrophularia orthocarpus*, *Deschampsia calycina*, knotweed (*Polygonum douglasii*), *Lomatium leptocarpum*, calochortus (*Calochortus nuttallii*), and *Sedum douglasii*. Practically all of these were in bloom when the collections were made, and the field had the appearance of a flower garden rather than a pasture.

A similar substitution of native plants of little or no forage value for the true grasses is common in the region, as well as in similarly treated areas in the more moist regions of Washington. Such substi tutions are usually more noticeable in humid mountain areas than on the lower deserts, for, in the latter, when the scattering bunches of grasses are killed out, there is often nothing to take their place. One of these overgrazed native pastures in the wheat region west of Ritzville, Wash., is shown in Plate IX, figure 1. For a list of the shrubs grazed by sheep the reader is referred to subsequent pages, which discuss the conditions in the Warner Mountains of California, and to Bulletin No. 15 of the Bureau of Plant Industry, U. S. Department of Agriculture. It may be stated that no black sage was seen in the Blue Mountains, except small patches of *Artemisia arbuscula* on the north slope, until Bear Valley, near the Great Basin drainage, was reached.

As far as general vegetation is concerned the Warner Mountains of California do not differ materially from the Blue Mountains of Oregon; at least the main features are the same, and the general topographical features are very similar. The water supply, however, is much better in the mountains first mentioned. Indeed, it would be difficult to find an open range region where water is better distributed than in the

Warner Mountains to the east of Jess Valley. These conditions have been taken advantage of to a detrimental extent by the immense flocks of sheep which winter on the deserts to the southward and eastward in Nevada and Oregon. One characteristic feature of those portions of these mountains is the abundance of browse plants, which make them especially attractive to the sheep grower. Sheep need a change of ration in order to thrive to the best advantage, even if that change be to weedy pastures, which are ordinarily considered of little value. Often they appear to be benefited by such a change from a good grass pasture. This testimony of the herder is substantiated by the fact that when grass is abundant the sheep will feed on such bitter plants as the willow, poplar, and some of the so-called sunflowers previously mentioned. In this region such shrubby plants as the gooseberry (*Ribes lacustre*, *R. luteum*, *R. cereum*, and *R. aureum*), snowberry (*Symphoricarpos oreophilus*), willow, poplar, mountain ash (*Pyrus sambucifolia*), service berry (*Amelanchier alnifolia*), and *Purshia tridentata* are very abundant. At the time of this visit immense numbers of sheep were practically subsisting on these plants. There really was no grass. Even the banks of the rivulets were chopped up by the incessant tramping, and the steep hillsides, protected by jagged rocks, were dusty. The writer has never seen a more deplorable condition than existed here. The sheep region was visited about the 1st of August, and sheep were supposed to remain there two months longer. It is difficult to imagine what the animals could find to live on. On an area shown in Plate VI, figure 2, the snowberries had been cropped so that there was nothing left but short, barked stumps and old, woody stems. This is in the vicinity of an old corral, but photographs taken in the same region show that similar conditions exist over a large part of the mountains.

The range regions traversed between the Blue Mountains, in Oregon, and Reno, Nev., with the exception of the Warner Mountains, have much in common. The mesa region does not differ greatly in appearance, although the black sage of the northern part is almost entirely replaced to the southward over large areas, especially in the vicinity of the Black Rock and Smoke Creek deserts, as well as in the Humboldt Valley, by the saltbushes, hop sage, bud sage, red sage, and white sage. These sage plants are of much more value as winter feed than the saltbushes. In this general region eight sinks were passed over. Some of these had water in them in places, but for the most part they were dry, the surface being smooth, showing level narrow fissures, and having no vegetation. The main areas of this character seen were in the Harney, Guano, and Catlow valleys, in Oregon; Surprise Valley, in California; and Long Valley, Smoke Creek, Black Rock, Humboldt Sink, and White Plains, in Nevada. All of these areas located in the lower portion of their drainage basin have as a first distinct zone of

vegetation salt grass (*Distichlis spicata*) and bordering it grease wood (*Sarcobatus vermiculatus*). These are in turn surrounded by the usual shrubs of the desert. In places where the drainage waters empty into the basins the vegetation is of course very much modified. It is here that the ranches occur, and it is upon the impounding of the spring waters which reach these sinks that the reclamation of these deserts depends. These areas, however, are now no part of the range, but they serve for the culture of winter feed for stock and are in the main patented holdings. The condition in the higher mountains was discussed in Bulletin 15 of the Bureau of Plant Industry, U. S. Department of Agriculture, to which the reader is referred.

Surrounding many of these desert sinks a peculiar condition exists as regards the distribution of vegetation. On the edges of the majority of them there are sandy drifts of varying magnitude, in which all of the desert shrubs may be found growing promiscuously. These accumulations of earth are derived from the desert basins during the dry, windy weather, and they are consequently very different from the ordinary sand dune, inasmuch as they, as well as the desert basins themselves, are very alkaline, the salts being blown out during the dry season. The vegetation of one of these dunes in Long Valley, Nevada, will serve as an illustration. There appeared in these mounds grease wood (*Sarcobatus vermiculatus*), black sage (*Artemisia tridentata*), bud sage (*Artemisia spinescens*), hop sage (*Grayia spinosa*), and saltbush (*Atriplex confertifolia*). On the "sleek desert" sides of these mounds occurred a scattering growth of salt grass, sometimes extending over the mounds, while on the edge of the more salty areas were also scattering growths of suaeda (*Dondia depressa erecta*) and iodine weed (*Spirostachys occidentalis*). None of these shrubs except the first mentioned is to be considered a salt-loving plant, but all were able to thrive here, doubtless because they became established before the drifts. For the same reason they are not to be considered sand binders, although they did serve that useful purpose here.

The feed on the desert mesas of Catlow Valley is furnished almost entirely by needle grass (*Stipa thurberiana*), orchard barley (*Sitanion longifolium* and *S. villosum*), prairie June grass (*Koeleria cristata*), wheat grass (*Agropyron* sp.[a] G. & H. No. 306), Indian millet (*Oryzopsis cuspidata*), and giant rye grass (*Elymus condensatus*). To these should be added Nuttall's saltbush (*Atriplex nuttallii*), which grows here, as is common with this species, almost pure in irregular areas, usually of a few acres in extent, in the general sagebrush mesa. The grasses, it must be understood, are in small scattering bunches, and it would doubtless take more than 50 acres to support a steer for one year on the general mesa. The conditions described in Steins and Pine

[a] This species, although quite abundant, was not secured in proper condition for determination.

Forest mountains in last year's report apply equally to the foothills and mountains here and need not be repeated.

One hundred miles south of this region, in the vicinity of the Black Rock desert in Nevada, the conditions are very different although the general appearance of the two regions is similar. In the more southern locality the black sage is almost absent on the general mesa, being confined to the higher elevations in the hills and mountains, as is the case over large stretches on the gently sloping hillsides surrounding the Black Rock desert, as well as in the vicinity of Lovelock. Saltbush (*Atriplex confertifolia*) is the one desert shrub and practically the only plant in evidence at this time of the year over very extensive areas. The vegetation in the vicinity of Boiling Butte will serve as a representation of the flora. Quite a collection was made here from the "sleek" Black Rock desert to the top of the butte. The first plants in the edge of the deserts are iodine weed (*Spirostachys occidentalis*) and pahute weed (*Dondia depressa erecta*) in bunches along the edges of the desert. These are followed in turn by a scattering growth of salt grass (*Distichlis spicata*), grease wood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex torreyi*). The latter thrives on more alkaline areas than the grease wood. On the general mesa are scattering growths of shrubbery such as saltbush (*Atriplex confertifolia*), bud sage (*Artemisia spinescens*), tetradymia (*Tetradymia spinosa*), red sage (*Kochia americana*), hop sage (*Grayia spinosa*), rayless golden-rod (*Chrysothamnus viscidiflorus*), and white sage (*Eurotia lanata*). All of the mesa plants extend up the side of the butte for a considerable distance and the red sage, hop sage, and white sage, together with *Tetradymia canescens* extend to the very top, where there are also found *Eriogonum dichotomum*, *E. microthecium*, and *E. hermanii*, *Gilia pungens*, bed straw (*Galium multiflorum*), and *Lygodesmia spinosa*. The black sage does not appear except at the higher altitudes about 600 feet above the general mesa. On the buttes there was a little Buckley's bluegrass (*Poa buckleyana*), while Indian millet (*Oryzopsis cuspidata*) was found on the sandy knolls on the mesa. The shrubbery, however, is the most important feed, and all of the varieties mentioned are utilized, with the exception of the rayless golden-rod and the gilia. On the higher Granite Mountains to the northward there is a scattering growth of juniper and, of course, more feed, consisting of species of clovers and sedges, together with the bluegrasses and sheep fescue already mentioned for the region. The feed in the vicinity of the hot spring was in striking contrast to that of the mesa and desert. The most conspicuous plant in the water is bulrush (*Scirpus olneyi*), which is found even in the middle of the stream a short distance from the boiling spring. Farther along where the water was cooler, beard grass (*Polypogon monspeliensis*), *Scirpus americanus*, and prairie bulrush (*Scirpus campestris*) throve. Farther

removed from the hot water, and evidently in earth containing considerable soluble salt, were small areas of giant rye grass (*Elymus condensatus*), wild wheat (*Elymus triticoides*), and squirrel tail (*Hordeum jubatum*). Everywhere there was a robust growth of salt grass, which was very heavily covered with the secretion so characteristic of it in this region. All these were, of course, grazed to a large extent. Attention is called to the fact that our animals refused to feed on the salt grass here for the first time, owing, no doubt, to this covering of salt.

In places on the edges of the desert there is another salt-secreting plant *Eunanus bigelovii* (?) (No. 535 Griffiths and Hunter), which the writer has met with several times. It is always most abundant and is most abundantly supplied with the secretion in the vicinity of borax deposits. Last year it was found to be very common near Wild Horse and again at this place. The salt secreted by this plant, however, is very different from that of the salt grass, inasmuch as it assumes a crystaline structure when dry.

About 4 miles from the hot spring mentioned, we came across a very peculiar cool spring in the middle of the Black Rock desert. The area immediately surrounding this spring is interesting in showing the plants that thrive to the best advantage in this strikingly alkaline situation, especially since all those which grow here are of value for grazing purposes. This spring was situated in a hillock about 12 feet high in the middle of the level salt desert. The water formerly broke out at the top of the mound, but now comes from the side and runs only a few feet before it sinks into the ground. There was a scattering growth of salt grass all around the hillock and on the shady side a thick growth of grease wood. The seepage ran out on the desert about 50 feet and sank into the ground. A patch of squirrel-tail (*Hordeum jubatum*) and *Scirpus americanus* was growing in the seepage water. This was practically the only pasturage found for our animals on the entire trip of 100 miles from Deep Hole to Lovelock. The plants specified above formed the only vegetation aside from some of the blue-green algæ forming a scum over the entire surface of the ground, which was kept moist. The water, although cool, was intensely alkaline.

It is to be understood, of course, that the region which was traversed between Smoke Creek and Lovelock is used mainly as a winter range for sheep. There are in this region a few cattle camps, and the Deep Hole Company has control of the Granite Mountain region, in which there is, of course, better feed. In places between Rabbit Hole and Lovelock, and especially eastward from Pyramid Lake, there are very extensive areas of white sage (*Eurotia lanata*) on the mesas and foothills and very often extending into the mountains. The finest areas of this plant seen were located 20 miles or so north of Lovelock and

in the vicinity of Rye Patch. This, together with saltbush (*Atriplex confertifolia*), bud sage, hop sage, and red sage, constituted the main browse, while the grass feed is produced mainly by Indian millet (*Oryzopsis cuspidata*) on the lower sandy areas and Buckley's bluegrass (*Poa buckleyana*), Wheeler's bluegrass (*Poa wheeleri*), and a little sheep fescue on the higher areas. Very little of the latter was seen in this vicinity, but it was very abundant in the pine forest mountains to the northeast of here last year.

The condition of the feed now as compared with former times is very difficult to estimate. There has been so little attention paid to the purely winter grazing grounds that there are but few data regarding them. Water is so scarce here that pasturing is possible only when there is a heavy fall of snow, and the character of the vegetation is such that it is of but little value except for winter feed. Consequently the thousands of sheep which winter in the region live on browse of the desert during the winter months. If the snowfall is copious they are able to get down to the mesa, but during dry winters they feed around the summits of the mountains, within traveling distance of snow, which is often their only source of water for several months of the year. It is to be understood, of course, that many flocks of sheep congregate around such places as Lovelock and Carson Sink for the purpose of obtaining hay for a portion of their winter ration, and thousands are driven here to be fattened for the markets. Consequently this desert, which to the ordinary observer has neither feed nor water, is of great importance, for it supplies feed of a coarse kind upon which thousands of sheep pass several months without other expense than herding. As stated in last year's report, there is need of close study of these ranges in the winter season, something which has not yet been attempted.

Although the feed is mainly browse, there occurs somewhat of a change of ration between late fall and spring. The white sage, red sage, hop sage, and saltbush are mainly of value as early winter forage, while the bud sage becomes valuable in late winter, when the bud-like twigs begin to develop, the young leaves and tender shoots being relished by all stock. At this season there are also many winter annuals, which are eaten by sheep especially.

MEADOWS AND HAY CROPS.

The main cultivated crops throughout the region described are four in number—alfalfa, timothy, redtop, and grain. Throughout the entire region alfalfa is the main irrigated crop, especially in the lower areas, while along the higher courses of streams in poorly drained areas timothy and redtop are extensively grown. Grain for hay is the common and prevalent crop in the wheat areas. In the North

Yakima region considerable clover, orchard grass, and Kentucky bluegrass are raised, the latter usually for pasture. While bluegrass thrives here, it is not considered a paying crop for hay, especially when compared with timothy and alfalfa.

ALFALFA.

It is not necessary to go into details regarding alfalfa, as its growth in this general region has recently been discussed at considerable length by a member of the office staff.[a] Some additional points with reference to it, however, are of sufficient importance for record at this time.

It is unusual, especially in the West, to attempt to grow alfalfa without irrigation, but a few experiments observed appear to indicate that production in this way may become of some importance in certain favored localities. Two small areas with no irrigation whatever were seen near Prescott, Wash., which bore much promise. The best of these was on the farm of U. L. Malloy, about 7 miles from Prescott. This had not been cut when seen, but it would yield, apparently, about 2 tons of dry feed per acre. Another area a short distance west of Ritzville, in the same State, also showed considerable promise. Here it was evidently intended to be used as a summer pasture for hogs. The growing of alfalfa without irrigation deserves attention, for there are probably many limited areas in this general region where it can be grown successfully without the aid of an artificial water supply.[b]

The ability of this crop to withstand large amounts of soluble salts in the soil was especially noted at Lovelock. It is truly remarkable what has been done in the upper settlements here in the reclaiming of alkaline desert lands. Much of the best alfalfa land above Lovelock, where the finest crops are now grown, was recently what is popularly known as "hilly grease-wood land," which is always alkaline. This land is characterized by having a rather heavy growth of grease wood and saltbush (*Atriplex torreyana*), with the bushes as a rule situated on mounds 1 to 3 feet high, making of the generally level plain a very rough and uneven surface. Before the land can be handled at all the brush must be gotten rid of and the mounds must be leveled off; then comes the task of getting an alfalfa crop established. To one who is not an expert in alfalfa culture the task would appear hopeless. A grain crop, usually wheat or barley, is raised for one or two years, until the land is subdued, when alfalfa is sown, in the majority of cases without a nurse crop. The surface salt in the heaviest deposits is removed by flooding and draining rapidly just before the seed is

[a] A. S. Hitchcock. Cultivated Forage Crops of the Northwestern States, Bulletin No. 31, Bureau of Plant Industry, U. S. Department of Agriculture, 1903.

[b] Alfalfa is grown quite successfully without irrigation in the wheat-growing districts of eastern Washington, yielding one and sometimes two cuttings a year.—*W. J. S.*

sown, when this is possible. When once the plants have become established and a soil cover is obtained the battle appears to be nearly won, for with a very moderate amount of water these soils produce much better crops than the lighter better drained nonalkaline areas. Constant care is necessary, however, for the breaking of the soil cover over a small area, due to imperfect seeding or too great an accumulation of salt in the surface layers, soon allows salt grass to get a foothold, and this needs no encouragement in such soil to take possession very rapidly. With such a limited supply of water as has been available during the past few years it has evidently been exceedingly difficult to get a crop established. Mr. A. F. Campbell showed some areas in one of his fields where it took five years to establish the crop. It is a common thing here, it is said, to see portions of a field which raise fine crops having a very noticeable accumulation of salt on the surface in the early spring. This disappears with the establishment of a soil cover. Indeed, several such areas were pointed out, and in one case unmistakable crusts of salt forming after the cutting of the second crop were seen. Of course the margin between success and failure under such conditions is very narrow, but the successful culture of alfalfa on such lands points to this legume as the leading and most promising alkali-resisting forage crop.

The greater part of the alfalfa in the valley is raised for sale, although there are many large holders who feed all and more than they can produce themselves. In August, when this region was visited, the crop was selling at $5 per ton in the stack, or $7.50 per ton baled, f. o. b. at Lovelock. Information from several sources indicates an average yield of 4 tons per acre, and the cost of handling it is estimated at about $6 per acre. This leaves a clear profit of about $14 per acre. It is not surprising under the circumstances that alfalfa land commands high prices, nor is it strange that more land is brought under cultivation than the water supply justifies.

TIMOTHY AND REDTOP.

The methods of handling timothy and redtop, especially along the upper courses of streams and narrow bottoms, and the reasons for the same, are of interest. A very large proportion of these two crops, except in the Ellensburg region, in Washington, along our line of travel from Wenatchee to the British border, in the Blue Mountains, along the Blitzen River, and in the Warner Mountains of California, is raised on uncultivated land. The small amount of labor involved doubtless accounts for this method of handling the crops, but in many localities it is rendered necessary by the difficulty of getting on the land in the mountain regions until very late in the spring, because of the excessively moist condition of the soil. Again, in many situations where magnificent crops of timothy and redtop are raised it is rather

risky to plow the ground, for in narrow bottoms through which large volumes of water flow at certain seasons of the year the breaking of the land would result in all loosened portions being carried away by the first freshet. After this, gullying would follow very rapidly. In a state of nature the sedges (*Carex* spp.) and the native clovers form very effective soil binders in these places, and to disturb them without at the same time introducing other plants which serve the same purpose would be hazardous. The feed produced by these sedges, however, is rather small in quantity and often poor in quality, especially when hay is desired. The rancher therefore introduces timothy and redtop and supplants the native forage plants and soil binders without disturbing the soil. There appears to be no established time for seeding. Often the seed is scattered on the snow. Sometimes it is sown in the fall and at other times in the spring, apparently with equally good results. Along the Okanogan River and Cow Creek, in Washington, as well as in the Warner Mountains, in California, many fields of timothy were seen which were established in this way. (Pl. VII, fig. 1.) Some fields yield as much as two and a half tons per acre. Along the Okanogan and other streams in north central Washington there is a great deal of brush, especially willow, alder, and wild rose. The practice is to cut and grub these out, burn the brush, and scatter timothy and redtop seed at the first favorable opportunity. Of course much more seed is required when the land is not plowed, and it usually takes several years to secure a good stand. Along Cow Creek some meadows established twenty years ago on sod are in reasonably good condition to-day, although they have been cut for hay and pastured during the winter every year. The Gundlach Live Stock Company, whose holdings lie between Smoke Creek and the Black Rock deserts, in Nevada, follows the practice of running a clod crusher over its meadows in the spring after the cattle are taken off, in order to break up the manure which would otherwise be raked into the hay the following season. Alsike clover sown with redtop and timothy here seems to thrive better than red clover, and timothy is in time run out by redtop. Neglected and improperly drained meadows are injured very much by the encroachment of sedges and rushes, with salt grass and small cord grass (*Spartina gracilis*) appearing in the more alkaline portions.

The amount of timothy and redtop seed scattered on uncultivated land in this region is very great, some large holders, such as the French-Glenn Live Stock Company, on the Dunder and Blitzen River, and Babcock & Benson and P. H. Schnebly, in the Wenatchee Mountains, using seed in ton lots. The two last-named holders are just inaugurating their experiments and have secured no results, but the first has much hay land established in this way, and its operations in draining swamp lands will result in a very large increase in its meadows in the near future.

In Jess Valley, in the Warner Mountains of California, timothy especially is being introduced, even into the rocky soils surrounding the bottom-land meadows, by diverting the waters from the melting snows to these areas and seeding in the manner already described. Much of this land could never be cultivated, and a large portion of it is altogether too rocky to be mowed without a great deal of labor expended in removing the rocks; but the amount of feed secured from such areas is greatly increased by this treatment. These areas are usually reserved until the hay is removed from the meadows, when cattle or sheep are turned into them for fall and winter pasturing. It is common here, as well as in the other hay regions visited, for hay to be sold in the stack, together with the feed in the field, to be pastured and fed out during the fall and winter as the stockman may wish, or as may be agreed upon.

The methods employed in the irrigation of timothy and redtop in many of the narrow valleys, especially the Okanogan, Cow Creek, Silvies River and its tributaries, and Jess Valley, are very interesting, inasmuch as they show that these grasses under certain conditions are able to withstand large quantities of water for long periods. The method of irrigation is a combination of ditching and damming processes. The flood water in the early summer, May to July, is diverted to the meadows in such a way as to cover them for periods varying from ten days to two or more weeks at a time. Ordinarily this would result in the destruction of these crops and in their being entirely supplanted by the sedges and the rushes. However, there is a large measure of success attained by this method of handling the waters. Being cool at this season and the water being in motion (i. e., flowing water), there is not the usual injurious effect. Neither is the method wasteful of water, for in a narrow valley there is but little loss to the irrigated lands below from having the waters spread out in this way in the upper stream courses. In many cases it is actually an advantage, as the flood waters are checked and distributed over a longer period. It would appear that timothy and redtop grown on meadows which are occupied to a large extent by sedges and native clovers, when handled in the manner described would need much more irrigation than when grown on cultivated land. One of these areas along Silvies River is shown in Plate VII, fig. 2, where these two crops, together with some alfalfa on the better-drained sagebrush areas, are grown.

The most extensive timothy and redtop region visited was that of the Kittitas Valley, at Ellensburg, Wash., from which much hay is shipped every year, mainly to Coast points. The alfalfa shipped from here is sold at about $4.50 per ton, while timothy and redtop sell for about $9.

AWNLESS BROME.

As is well known, one of the greatest brome-grass regions which has been developed in this country since seed of *Bromus inermis* was introduced by the U. S. Department of Agriculture some years ago is the Palouse region in eastern Washington, but the cultivation of this grass does not appear to have spread to the westward and northward to such an extent as one would expect. Awnless brome is grown in a limited way, however, in a few of the localities visited, and in all cases appeared to be promising. From the observations made, there seems little doubt that in the Pacific Northwest it will grow and make good returns wherever wheat can be raised for hay. Near the mouth of the Okanogan River a small area of this grass on irrigated land was seen that would cut at least 3 tons of dry feed per acre. An experiment conducted in the Okanogan hills, about 8 miles from the British border, was of much interest. An attempt was there being made to raise this grass on rather poor upland soil without irrigation. In the more favored spots in the field it made some hay, and nowhere in the inclosure did it fail to yield twice as much pasturage as could ever be expected on the native range pastures of the vicinity. Small areas of this grass were seen in several other places in this region, but they were usually in pastures, and sometimes this grass was considered by the ranchers of little value on account of its not being able to withstand close grazing well. It appeared to the writer, however, that in many cases the difficulty resulted from the fact that the stock preferred this to the native grasses, and that the poor development was owing to its not having sufficient chance to make a growth.[a]

Nowhere in the Blue Mountains was any awnless brome grass seen until Izee was reached. There Mr. C. W. Bonham was experimenting in a small but very intelligent way, having about an acre of it growing in a corner of his garden, some with and some without irrigation. The experiment appeared very promising. Mr. Bonham reports that it is difficult to get the grass started, but he thinks that if sown at the proper time in a favorable year, and if irrigation were practiced, less difficulty would be experienced. He believes that it will make a good crop without irrigation when once a stand is secured. Some persons in Bear Valley are said to be preparing to put in large acreages of this grass next season. There is little doubt that it will succeed in many places in these mountains, where a much poorer quality of hay is now raised.[b]

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[a] At the experiment station at Pullman, Wash., awnless brome grass was less injured by close grazing than any other grass.—*W. J. S.*

[b] This grass yields a large crop of hay the second year from seed, but thereafter is adapted only to pasture purposes.—*W. J. S.*

GRAIN HAY.

By far the greatest quantity of roughage in all the country traversed outside of the irrigated areas is produced by the cereals sown in the ordinary way and cut when the grain is a little under the "dough" stage. Wheat, barley, and rye are especially the grains handled in this manner. In the Big Bend, in Washington, wheat furnishes almost the only hay in many places, the common practice being for the farmer to get his hay crop from the edges of his wheat fields. The wheat fields are "trimmed up" ten days or two weeks before harvesting begins. This trimming consists in cutting two or three swaths around the field while the straw is still green. Many wheat raisers secure their entire hay supply in this way. It is also a common practice when bearded barley is raised for the grain to sow a strip of wheat on the outside of the field, this being cut for hay.

This method of producing hay was more general on the north slope of the Blue Mountains than in any other section visited. Two factors contributed to the importance of the grain hay crop here, this year at least. In the first place, the past season was very dry, and the wheat crop consequently was very poor. On this account many fields were cut for hay instead of grain when it became evident that the yield would be small and poor at best. In the second place, being on the border of the area where a demand exists for winter feed for stock, wheat hay is nearly as paying a crop as the wheat itself.

Wheat straw is largely made use of here as a winter ration, especially for cattle. The stockman usually buys a field of straw and stubble, and winters his cattle very often with no other feed. This is better than the short range of the present day, but the stock usually come out of the winter in very poor condition. This method is a decided advantage to the wheat and hay grower, for, in addition to the ready cash, the land is improved by having the cattle upon it during the winter season.

Rye is a very important hay crop all through the region, and it is especially good on the sandy and poor soils along the Columbia and Snake River bottoms and portions of the Eureka flats, as well as on better soil. It is by far the most productive sandy-land crop, but is a rather exhausting one when the grain is allowed to mature. It appears to be the leading hay crop in all new communities, and is very extensively grown in the Blue Mountains, where especially good crops were seen in the vicinity of Ulkiah and Izee. At the latter place it was estimated that more hay was derived from this source than from all others combined.

Of the grain crops sown primarily for hay, the awnless form of barley is probably the one that is considered best. This is grown largely in the wheat regions of Washington and in the Blue and the

Warner mountains, as well as in the Okanogan region and the irrigated communities of Ellensburg, North Yakima, and Lovelock, Nev. It is a common practice in the irrigated localities, when alfalfa fields have become thin owing to the length of their establishment, lack of care, overirrigation, or accumulation of alkali, to sow barley or wheat, either in drills or broadcast, early in the spring. This answers several beneficial purposes. The first crop of hay cut is greatly increased, the fields are in much better tilth, and a more perfect soil cover is secured early in the season, preventing a rapid evaporation from the soil during the spring and consequently decreasing the soluble salt content of the surface layers. It is said that this crop does not act injuriously on the alfalfa. It is a common practice also to scatter alfalfa seed in the meadows at the same time. This kind of a mixture makes excellent hay, and nearly doubles the quantity secured at the first cutting.

CHEAT.

Cheat[a] and grain (wheat, barley, and rye) are the main hay crops in the Blue Mountains of Oregon. The majority of the ranchers spoken with consider cheat superior to grain hay as feed for cattle and sheep. A few fields were seen in Washington, but it is not by any means so common there. It is not considered as good feed as timothy and redtop, but it makes a better yield on higher and drier areas than these crops. Nearly all ranchers in the Blue Mountains make a distinction between cultivated cheat and what they call wild cheat, which is described as the short-awned brome (*Bromus marginatus*) in the publications of the United States Department of Agriculture.

ROOT CROPS.

Some sheep men on the north slope of the Blue Mountains are beginning to raise considerable quantities of mangel-wurzels, beets, and carrots for the winter feeding of sheep. Messrs. J. E. Smith & Sons, who have the largest sheep interests in this area, report good success in their experiments in this direction. They are obliged at the present time to feed their sheep thirty to fifty days, as compared with ten days or two weeks years ago, when there was more open range. Thus far they have produced crops of this nature for only a limited number of their flocks, and these are fed mainly during the lambing season. The roots are chopped with a machine and fed with no further preparation. They consider these crops very profitable for this purpose. It is quite probable that ruta-bagas could be profitably added to this list.

[a] The species grown here appears to belong to *Bromus racemosus* rather than *Bromus secalinus*, under which name it is handled by seedsmen.

NATIVE HAY CROPS.

Wild wheat (*Elymus triticoides*).—This is without doubt the most important native hay plant of the region. It is known locally as blue-joint. Attention was called to this crop last year, but its importance was still more impressed upon the writer this year. In early days this was the main hay crop in the vicinity of Lovelock, and the name "Bib Meadows" is said to have originated from the extensive areas of hay land along the lower course of the Humboldt River where this was the principal species. Wild wheat was not met with on our route in any great quantities until we approached the Great Basin slope of the Blue Mountains, except in one locality on the Okanogan bottoms, where there was a large area of the white, or densely glaucous, form, which was so abundant at Quinn River Crossing, near Winnemucca, last year. At Izee, on the South Fork of the John Day River, it appeared to be of considerable importance in both hay and pasture land. Its best development, however, appears to be in the stiff, rather poorly drained, heavy, nonalkaline soils of the Great Basin bottoms. Here it grows out to the edges of the sagebrush areas, and often occurs in small quantities scattered for some distance into these areas, so that when they are irrigated, as is often the case, this grass springs up and extends with surprising rapidity, being spread, doubtless, to some extent by seeds, but more especially by its creeping rootstocks.

In the Lovelock region at the present time it is considered a weed, on account of the persistence with which it remains and spreads in cultivated fields. When lands are being brought under control it is very common to find areas of this grass scattered through the fields for some time, and it is almost invariably found along the irrigation ditches, where it serves the useful purpose of holding the embankments.

Bunch bluegrass (*Poa lævigata*).—Next in importance to the wild wheat is the bunch bluegrass, which is sometimes known as wild redtop. In the desert basins thousands of tons of this hay are cut each year. It grows in somewhat similar situations to the wild wheat, though usually on higher ground, and it appears to be able to withstand a greater amount of drought. Its habit of early maturing renders it of extreme importance in the Great Basin region. Often the only moisture which meadows obtain is from spring flooding, and this plant appears to be able to mature a fairly good crop of hay under these conditions. The most extensive areas of this grass were seen in the Catlow and Guano valleys and in the Deep Hole region on the edge of the Smoke Creek desert.

Giant rye grass (*Elymus condensatus*).—In all localities visited this is an important forage grass, but it is in the Great Basin that it attains its greatest importance as a hay crop. If cut when in bloom it makes

fairly good hay, but if left standing longer than this it becomes very hard and woody.

Sprangle top (*Scolochloa festucacea*).—As stated in last year's report, the importance of this plant as a forage crop is surprising. Its distribution appears to be very local. The only place in this region where the writer has seen the plant is in Harney Valley, and there only in the vicinity of Malheur Lake, where it was fully reported upon last year, and along the Dunder and Blitzen River, where it was just as important as on the islands of Silvies River. Large quantities of hay were made of it this year on some of the "P" ranches.

Miscellaneous forage plants.—A very large part of the native hay throughout this region is obtained from the sedges and rushes, mixed with more or less of the native clovers, of which *Trifolium involucratum* and *T. microcephalum* are the most important on the lower areas and *T. beckwithii* in the mountains. *Trifolium cyathiferum* should also be mentioned as being of much value. Of the sedges, *Carex utriculata*, *C. lanuginosa*, *C. tenella*, *C. nebraskensis*, and *C. douglasii* provide the greatest quantity of feed and are of importance in the order named. They produce hay of less value than the grasses and clovers, but are much superior to the rushes, which are represented mainly by *Juncus balticus*, *Eleocharis palustris*, *Scirpus campestris*, *S. americanus*, and the tule (*S. lacustris*). Mention has been made of the extraordinary area of *Eleocharis palustris* in the Grand Coulee. Another equally striking illustration of the development of the *Juncus balticus*, also known as wire grass, came under observation along Crab Creek in Washington. Here it has been the practice for years to flood the meadows for a month or two after the hay crop has been removed for the purpose of attracting wild ducks, which are fed and systematically hunted during the open season, with the result that the meadows have grown up to almost pure *Juncus balticus*. This species almost invariably occurred in greater or less quantity in all meadows where timothy and redtop have been established without cultivation, more especially where the water is not under good control and is allowed to remain on the ground for long periods.

RECLAMATION OF SWAMP LANDS.

There were two regions on the route followed where gigantic operations were in progress for the drainage of swamp lands along streams which have a slight fall and are without any defined channels. The undertaking which came under direct observation was that inaugurated and carried on by the French-Glenn Live Stock Company along the Dunder and Blitzen River in eastern Oregon. This stream receives the drainage of a large portion of the western slope of Steins Mountains

and empties into Malheur Lake. Both the upper and lower courses have well-defined channels, but the middle course is a swamp, where the water spreads over the bottoms and covers an area 8 to 10 miles in width by 12 to 15 miles in length. The region is now a huge tule swamp, where there is much feed around the edges, and cattle even work their way out into the swamp long distances; but it is during winter, when the ice is able to bear the cattle up, that the greatest amount of benefit is derived from it. At the present time the returns from the swamp are small. Besides this feature of small returns, the losses in the spring are very heavy. Cattle are usually so weak at this time of the year that when the ice begins to give way, they mire in large numbers and have not the strength to wade out.

The intention at present is first to cut a channel for the river, and then construct laterals as occasion demands for the purpose of draining the area. When this is accomplished it will be necessary to devise a method of irrigating this drained land properly. The construction is so planned that the channel cut for the river will unite with a large irrigating ditch covering a sagebrush flat. The water is simply turned on this sagebrush land at present, and what may is allowed to develop. Later this area will no doubt become a valuable alfalfa meadow and be irrigated systematically from the drainage waters derived from the swamp.

When this swamp, which is to a large extent a mass of peat, has been placed under control, the best crops to grow there will have to be selected. There is little doubt that the most profitable will be forage crops. The behavior of timothy and redtop all through the region under little or no cultivation makes it quite certain that these grasses will find an important place in the crops grown here in the future.

Similar areas have already been successfully drained along Pitt River, in Modoc County, Cal. Here the tule swamp lands are proving exceedingly well adapted to alfalfa growing. It is stated on good authority that some of the best alfalfa lands in the county are situated on these tule swamps.

The land in these swamps is, of course, exceedingly fertile, the drainage slight, and the waters different from those usually found in this region. They are not particularly alkaline, but are very highly colored with dead herbage, as is the case in some of the swamp lands in the Southern States.

The drainage of these areas, although a big undertaking, is only a portion of the difficulty involved in their handling. The method of managing them after they are drained and the crops best suited to them are problems which will require much careful investigation.

NEEDS OF THE REGION.

On account of such diversity of conditions it will be necessary to consider certain divisions of the territory more or less separately.

The greatest need of the Washington region, aside from the Okanogan River drainage area, is summer feed. As stated, this is principally a sheep region, where the animals are pastured the greater part of the year on the desert mesas of the Big Bend and contiguous regions in the winter and in the mountains for about three and one-half months during summer. The need of having animals in good condition in the fall, both for market and for entering the winter, and the necessity of an abundance of green feed for the best development of the lambs render these limited highland summer pastures of great importance to the sheep grower. On the other hand, winter feed is more abundant; for the deserts are extensive, and the irrigated hay lands, such as those of the North Yakima and Ellensburg regions, are producing more hay every year. For years past such communities have been shipping hay in large quantities to Coast points; in other words, they produce more hay than they can feed at home. For the greatest economy it is evident that the effort should be to increase summer feed so that enough stock can be summered in the region to consume the winter feed at home, thus saving transportation on raw material.

It was considerations of this kind that led Messrs. Benson and Babcock to offer to cooperate with the Department of Agriculture for the purpose of determining what could be done to increase the summer feed in the Wenatchee Mountains, in which they are interested.

Messrs. F. E. Benson and W. H. Babcock have come into possession of a large body of railroad land in the Big Bend at Trinidad, and a similar but smaller area in the Wenatchee Mountains southwest of Wenatchee. Their purpose has been to organize a sheep ranch on a sound basis, having definitely provided both summer and winter feed on lands which they control either by title or rental, instead of depending upon the open range for the larger part of both seasons' feed and being compelled to go out of business sooner or later, as is the case with so many of the stockmen in the West. The recognition of their need of more and better summer feed, which is the need of the region in general, induced them to offer to cooperate with the Department of Agriculture in experiments to improve the forage conditions of the summer grazing grounds by donating the use of an entire section of fenced land wherein experiments could be conducted. This offer has been accepted by the Department, and experiments have been begun under the direction of the Agrostologist. The objects of these investigations will be the introduction of forage plants which will increase the feed on highland pastures; a study of the effect of systematic grazing as compared with present methods, and of seeding at different seasons of the year, both with and without cultivation; a study of local

meteorological conditions as affecting the growth of forage plants; a study of the native vegetation in its relation to the stock industry, and such other problems as may present themselves during the prosecution of the investigations.

The land set aside for the experiments is well adapted to this purpose. Being located in a typical grazing area and having been excessively pastured for a number of years, any advantage gained by treatment will point to methods of renovating denuded ranges. The land is described in the Government surveys as Sec. 23, T. 20 N., R. 20 E, and is locally known as the Babcock headquarters section, on account of the corrals located there. It has an altitude of approximately 5,000 feet. The region was gone over rather hurriedly in June. At this time there was no feed. Although the snow was still lying on the ground in deep drifts, the tract had already been pastured this season, for at that time none of the land was inclosed. Mr. J. S. Cotton, who has been placed in immediate charge of the work, reports that grasses have been nearly exterminated over a large part of the tract. The section, being located on the line of travel to and from the high mountains, has been grazed twice each season, in June and October, for a number of years. The soil is badly packed and cut by the flocks of sheep which have tramped over the ground while it was still wet from melting snows. In many places the soil has begun to wash badly.

While this is rather an extreme case of denudation, it nevertheless represents the exact condition of much of the range country at the present time, and shows what much more of it will become shortly if present methods are pursued. Any success in reestablishing the grass cover will be extremely important for all highland pasture regions.

Mr. Benson most aptly expresses the necessity for this work, as well as the needs of the region in general, in a letter to the Agrostologist, as follows:

> The shortening of summer pasture by forest reserve regulations and the overgrazing by sheep of the remaining pastures, coupled with the greatly increasing alfalfa production in the irrigated valleys to supplement the winter ranges, make the summer range more and more disproportionate to the winter range, until the important question now is, "How much stock can you carry through the summer?" and not what it has heretofore been in this country, "How are you fixed for hay? And how much stock can you winter?" Therefore it becomes very important to know what grasses or forage plants will do the best and yield the greatest amount of good pasture.

In the Blue and the Warner mountains the main problem is one of hay production. The winters here are more severe and stock must be fed for longer periods each year. Of course, the summer feed is also very short at times on account of the thousands of sheep which summer in these mountains. But the communities established here have managed in a measure to reserve some feed for themselves by establishing "dead lines" against sheep and by maintaining them at times with force.

Several of these communities are developing the dairy industry quite rapidly, and already Camas Prairie butter is of some importance in the local markets. The necessity of good pastures and hay crops for the proper development of this industry is obvious.

While much has been done by the Department of Agriculture and the State experiment stations in the development of the forage resources of the West, very little attention has been given in this country to experiments in this line in the mountains. The peculiar conditions existing in these mountain settlements render the necessity for new hay and pasture plants particularly pressing. In many localities the ranchers and farmers are already experimenting on their own account and will determine in time, by a laborious and expensive process, what could very properly be determined at public expense. The difficulties encountered by these farmers are enhanced by the practice, common with certain seedsmen, of foisting upon the farmer, under a new and frequently high-sounding name, some worthless weed, or some plant of very limited usefulness. To illustrate: Some people have invested considerable money in the seed of a supposedly new forage crop under the name of "Billion-dollar grass," and were surprised when they were informed that it was an annual grass, and much chagrined when they got no results on dry land without irrigation, or when with irrigation on rich alluvial deposits they secured only a scattering growth of the common barnyard grass—a common weed all over the United States.

As stated elsewhere, grain, hay, and cheat are the main hay crops in these mountain settlements at present. These certainly can be improved upon. Some timothy and redtop are grown, and awnless brome is being gradually introduced. It appears to the writer that some work of an experimental nature would be very desirable in these mountain communities. A series of experiments conducted here for about three years with a carefully selected list of about fifty forage plants would demonstrate what forage crops could be grown to advantage at these high altitudes and would be of inestimable benefit to the pioneers who are building homes here.

In the numerous desert basins where water available for irrigation can be secured for only a short period, or, in other words, where the meadows can be irrigated in late winter only and where now the sedges and rushes are the main hay crops, the need of a perennial hay plant that will mature early is evident. The native plant, bunch bluegrass (*Poa lævigata*), seems the most promising for this purpose. As previously stated, this furnishes much hay at the present time and appears well adapted to this form of treatment. The characteristics which make this a valuable grass are discussed elsewhere and need not be repeated here. It is possible that some annual crops might be found to be profitable here, but it must be considered that the returns per acre,

which are very small, make the profits from the cultivation of large areas for annual crops rather problematical.

In practically all of the irrigated districts where alfalfa is raised the settlers were nearly all looking for some strain of alfalfa which will thrive with less water than the common stock. The introduction of Turkestan seed a few years ago having resulted indifferently, attention has recently been attracted to "dry-land" alfalfa, concerning which much has appeared in periodicals during the past year. The growing tendency in all the irrigated districts to bring more land under cultivation than can be properly irrigated has emphasized the demand for a crop that may be grown with little or no irrigation in arid climates. Correlated with a scarcity of water is the accumulation of alkali, which calls for the development of strains resistant thereto.

The matters just mentioned, together with the determination of the best method of handling the swamp lands and the best hay crops to grow upon them, appear to be the most important forage problems of the region.

PLANTS INJURIOUS TO STOCK.

But little can be added to what was said last year regarding poisonous plants in pastures and meadows. In all swampy places, especially in the vicinity of springs, there occur more or less wild parsnips (*Cicuta vagans*). This and larkspur (*Delphinium scopulorum*) are dreaded by ranchers in the spring of the year, especially in the Great Basin region.

The slender fescues (*Festuca microstachya* and *F. octoflora*) are said to cause injury about the time that the seed is ripening. The injury is done by the seed working its way into the walls of the animal's stomach. This is reported on what is, without doubt, reliable testimony from two observers, both of whom were in position to form opinions from post-mortem examinations. Mechanical injuries of this nature are not at all uncommon, the best-known examples being those caused by squirrel-tail grass (*Hordeum jubatum*), the awns of which work their way into the lining membranes of the mouth, and needle grass (*Stipa* spp.), the seed and awns of which work their way into the wool and flesh of the sheep. To these might be added the triple-awned grass (*Aristida americana*) and six weeks' grass (*Bouteloua aristoides*) of the Southwest, which are dangerous to sheep at certain seasons, the awned seeds in the first instance and the spikelets in the second case acting in the same way as the seed of the needle grasses.

WEEDS OF MEADOWS AND PASTURES.

The ordinary annual weeds of the farm can not combat with alfalfa as handled in the irrigated West. Wild lettuce, which is a serious pest in parts of the wheat region, soon disappears from the field when

properly handled in alfalfa culture. The weeds which thrive in alfalfa are those which propagate by running rootstocks. Two such grasses, salt grass and wild wheat (*Elymus triticoides*), are at times quite conspicuous and much dreaded in the Lovelock district. It is a very common thing here to see patches of these two grasses, but more especially the former, making their appearance in alfalfa meadows and spreading with surprising rapidity. The salt grass is by far the most troublesome, because it finds in these soils congenial conditions, which at the same time are detrimental to the crop. Through cultivation, application of manure, and reseeding with alfalfa, or even a temporary grain-hay crop, which gives a soil cover, this weed can be kept in check. Although the salt grass is looked upon here as a weed, it would seem that the real trouble is with the soil and not so much with the weedy tendency of the grass. If the soluble salt content of the soil is kept down by the methods already enumerated, salt grass will not find congenial conditions. The difficulty seems to be simply one of alkali and not of weeds. The wild wheat, or blue joint, on the other hand, does not thrive in particularly alkaline soil, and is really a plant that can be handled as easily as the western wheat grass (*Agropyron occidentale*) on the prairies of the Great Plains.

Blue flag (*Iris missouriensis*, Pl. X, fig. 2) is a very serious pest in moist pastures. In portions of the Wenas Valley where pastures were overstocked there was a complete soil cover of this weed in many native meadows. In many places where it develops to this extent it would be hazardous to break the soil, for fear that it might be washed away. However, mowing would do much toward getting rid of blue flag, and an attempt should be made at every favorable opportunity to establish a more complete crop of timothy and redtop in such localities.

The dandelion is also a very serious pest in native meadows and pastures which have been in use a long time in northwestern Nevada and northeastern California. It has spread very rapidly of late in many sections of the West where little or no cultivation is practiced. It has been introduced doubtless with timothy and redtop, which are largely employed throughout the region to supplement and supplant the native vegetation. It is all the more serious because it is introduced in places where, on account of the location of the arable land in narrow strips along rivulets, its destruction by cultivation, which is the only known method of eradicating it, is impracticable or, in certain localities, hazardous, on account of danger of erosion when the sod is broken up.

The native plants which become weedy in the more humid localities under conditions of overstocking have been discussed elsewhere.

DISEASES INJURIOUS TO FORAGE CROPS.

All of the more important diseases of forage plants observed were caused by various species of smuts. This class of parasitic fungi injures more than one would suppose the development of native economic plants. While this is true, so little is known of the life history of these species that no suggestion can be made regarding their control further than to state that the spread of those species which attack hay plants could probably be checked by careful mowing and the removal of hay from affected fields before the grasses head out. The acreages are so large and the returns from them so small, however, that it is doubtful whether any method which would be successful would be financially justifiable.

Ustilago hypodites.—In portions of the Great Basin, as well as in the Okanogan region in Washington, a very large amount of damage is done by this smut. It attacks both giant rye grass and salt grass, transforming the undeveloped portions of the plants within the upper leaf sheaths into a black powdery mass. It was especially destructive in the Quinn River and Alvord regions in Nevada and Oregon last year, and again this year in Surprise Valley, California, and at Lovelock, Nev., on both hosts.

Ustilago scolochloa.—This smut attacks the valuable sprangle top (*Scolochloa festucacea*). Its black, sooty spores break through the epidermis on the upper side of the leaves, stunt the growth of all the leaves, prevent the upper ones from opening, and entirely destroy the seed. At the "sod house" on the lower course of the Dunder and Blitzen River some meadows, in which one-half to two-thirds of the vegetation consisted of this grass, had fully one-half of the plants smutted.

Tilletia fusca.—The hosts of this smut, the slender fescues (*Festuca octoflora* and *F. microstachya*), are annual plants, depending entirely upon seed for their reproduction. The fungus in this case transforms the seed into a black horn-like structure, filled with a compact black mass of spores, entirely destroying it in practically the same manner as the bunt destroys the kernel of wheat. Nothing short of the excellent seed habits possessed by these grasses would enable them to thrive at all, for there are many localities in eastern Washington where upward of three-fourths of the plants had all their seed destroyed. Reference is especially made to the region about 25 miles north of Prosser, where the above statement would be no exaggeration. At the same time another species of smut (*Ustilago mulfordina*) did some injury also.

Ustilago bromivora.—The seed production of the valuable short-awned brome grass (*Bromus marginatus*), as well as that of the closely related cheat, is very materially reduced by this smut. The injury to

the form of *Bromus secalinus* which has escaped from cultivation and grows as a weed seems to be much more pronounced than that of the cultivated form, which, as previously stated, corresponds more closely to *Bromus racemosus*.

Ustilago striæformis.—This common disease did more injury to timothy in Jess Valley, California, than the writer has ever observed elsewhere. It appeared to be confined here to well-drained areas, which were abundantly supplied by seepage from ditches, rather than to the more poorly drained or the drier portions of the meadows.

SUMMARY AND SUGGESTIONS.

NEEDS OF THE REGION.

The sheep industry is more in need of summer pasture than anything else. This is accounted for by the settling up of mountain meadows, the development of alfalfa regions, and the withdrawal of land from the public domain for timber reserves.

The mountain communities of the Blue and the Warner mountains need to have determined what hay and pasture crops can be grown in these highland regions to best advantage.

In the desert basins, where water for irrigation can be obtained for only a very short time, there is need of an early maturing perennial grass.

The alfalfa growers call for two new varieties of alfalfa—one which will survive with less water than the common form, and one which will resist the effect of soluble salts in the soil. The development of these two strains can be secured only through careful experimentation.

ABUSES.

The whole subject of abuses can be summed up under the head of overstocking, but there appear to be two practices which need special attention. At present stock are allowed on high mountain pastures too late in the spring. They should be taken from these pastures as soon as frost begins to disappear, so that the sod will not be injured. Even the carefully handled tame pastures of the East will not stand grazing at this period.

The second abuse of the range to which the writer wishes to call attention is the "cayuse nuisance." With the decline in the price of horses about 1894 these animals were allowed to run wild, with practically no attention, many herds not even being rounded up and branded. Under these conditions, of course, the horses multiplied and deteriorated rapidly on account of inbreeding, resulting in the overstocking of the ranges with animals which were all but worthless. It was this condition which led the legislature of Nevada, in 1897, to

enact a law providing for the destruction of these "unbranded wild" animals. During the past three years thousands of these horses have been shipped out of the country (Pl. VIII, fig. 2), thereby relieving the situation very much; but there are still altogether too many of them on the ranges. The quantity of range feed consumed by a good animal is no more than that eaten by one of these almost worthless "cayuses."

NATIVE GRASSES WORTHY OF CULTIVATION.

Wild wheat (*Elymus triticoides*).—It appears to the writer that wild wheat is worthy of extended trial under cultivation. It is promising in stiff soils where there is considerable moisture up to the middle of June. It is also of some promise for holding clay banks which wash badly in the more humid regions.

Bunch bluegrass (*Poa lævigata*).—The large quantity of excellent hay made of this grass all through the region traversed, as well as its good seed habits, make it a promising plant for cultivation.

Short-awned brome (*Bromus marginatus*).—In the highland region there is no native plant that gives more promise than this. At the present time large quantities of it are common all through the mountains in poorly cultivated fields. In Fox Valley several fields of cheat were seen where one-half of the yield consisted of this native species. When cut in season the quality is good, and its seed habits are excel lent, resembling those of rescue grass more closely than any of the cultivated species of this genus.

Mountain rye grass (*Elymus glaucus*).—Observations in mountainous regions tend to indicate that this species is of some promise. Several limited areas in the Blue and the Warner mountains suggest that it might be made use of in cultivation. A careful examination into the conditions in the Rocky Mountains, especially in the vicinity of Summit, Mont., strongly confirms this opinion.

Bunch wheat grass (*Agropyron spicatum inerme*).—The importance of this grass on the native ranges and the successful attempts which have already been made to grow it leave little doubt as to its value for cultivation, although the hay made from it is rather hard and wiry. Its value as a pasture plant may be questioned on account of its inability to withstand trampling. Some ranchers stoutly maintain that when once closely grazed it will not recover in a reasonable length of time.

Giant rye grass (*Elymus condensatus*).—The excellent seed habits of giant rye grass, its large yield, and its ability to thrive on stiff, hardpan soil along with salt grass render it of considerable promise for cultivation, especially in the Great Basin region.

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DESCRIPTION OF PLATES.

Plate I. (Frontispiece.) Map of Pacific Northwest, showing route traveled.

II. Fig. 1.—A good summer sheep range in the Blue Mountains of Oregon. In the foreground are willows, alders, and the service berry. On the hillside to the left is seen *Purshia tridentata*, with a liberal supply of the common grasses. Fig. 2.—A desert range in northwestern Nevada. In the foreground appears the "sleek" desert of Black Rock, with the Granite Mountains in the background. The white streak at the base of the mountains is caused by a mirage, and is at least 2 miles distant.

III. Fig. 1.—Good scab-land range near Trinidad, Wash. Black sage, bunch wheat grass, a little sheep fescue, and Sandberg's bluegrass constitute the main vegetation. Fig. 2.—Desert range near Mirage, Nev. Vegetation almost pure *Atriplex confertifolia*.

IV. Fig. 1.—Typical range view in the Okanogan Hills, Washington. Sheep fescue, bunch wheat grass, Nevada bluegrass, Wheeler's bluegrass, and giant rye grass are shown. Fig. 2.—Typical ranch in the Blue Mountains of Oregon.

V. Fig. 1.—A sheep range on the north slope of the Blue Mountains. The native vegetation here has been largely replaced by cheat. Fig. 2.—A denuded mountain meadow on the north slope of the Blue Mountains.

VI. Fig. 1.—Corraling ground in the Warner Mountains of California. In the center of the foreground is shown the condition of Indian currant (*Symphoricarpos oreophilus*). Fig. 2.—Winter range in northwestern Nevada. White sage appears on the lower area in foreground, while *Atriplex confertifolia* and bud sage are seen at the base of the hill and red sage on the higher slopes.

VII. Fig. 1.—Timothy and redtop on uncultivated land, Warner Mountains, California. Fig. 2.—*Bromus inermis*, irrrigated, near the mouth of the Okanogan River, Washington.

VIII. Fig. 1.—A narrow valley along Silvies River, Blue Mountains, Oregon. Timothy, redtop, native grasses, clovers, and sedges are cut here, usually on uncultivated ground, with some alfalfa on the better drained areas. Fig. 2.—A horse round-up, showing the cayuse, the menace of a large part of the range country.

IX. Fig. 1.—An overpastured highland meadow in the Washington wheat region. Yarrow is the most conspicuous plant. Fig. 2.—An overpastured lowland meadow, Wenas Valley, Washington. *Iris missouriensis* has taken possession.

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FIG. 1.—A GOOD SUMMER SHEEP RANGE IN THE BLUE MOUNTAINS OF OREGON.

FIG. 2.—A DESERT RANGE IN NORTHWESTERN NEVADA.

FIG. 1.—GOOD SCAB LAND RANGE NEAR TRINIDAD, WASH.

FIG. 2.—DESERT RANGE NEAR MIRAGE, NEV.

FIG. 1.—TYPICAL RANGE VIEW IN THE OKANOGAN HILLS, WASHINGTON.

FIG. 2.—TYPICAL RANCH IN THE BLUE MOUNTAINS OF OREGON.

FIG. 1.—A SHEEP RANGE ON THE NORTH SLOPE OF THE BLUE MOUNTAINS.

FIG. 2.—A DENUDED MOUNTAIN MEADOW ON THE NORTH SLOPE OF THE BLUE MOUNTAINS.

FIG. 1.—CORRALLING GROUND IN THE WARNER MOUNTAINS OF CALIFORNIA.

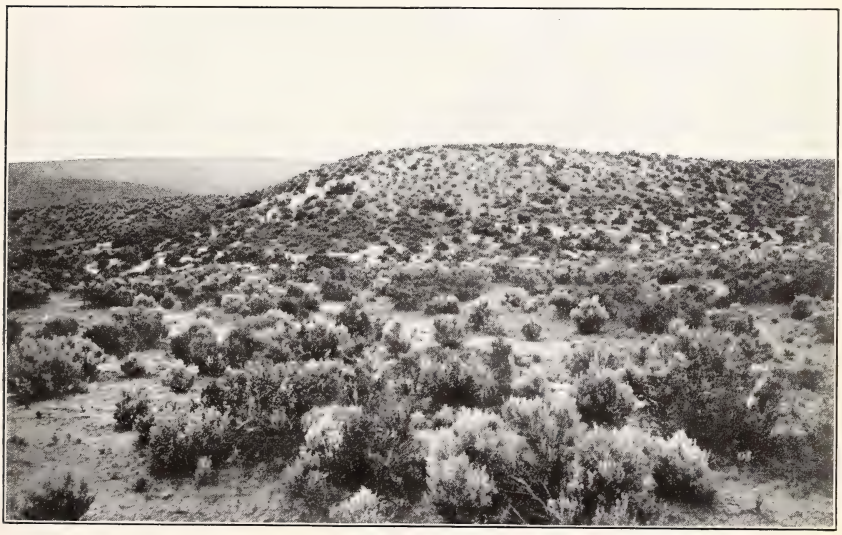

FIG. 2.—WINTER RANGE IN NORTHWESTERN NEVADA.

FIG. 1.—TIMOTHY AND REDTOP ON UNCULTIVATED LAND, WARNER MOUNTAINS, CALIFORNIA.

FIG. 2.—BROMUS INERMIS, IRRIGATED, NEAR THE MOUTH OF THE OKANOGAN RIVER, WASHINGTON.

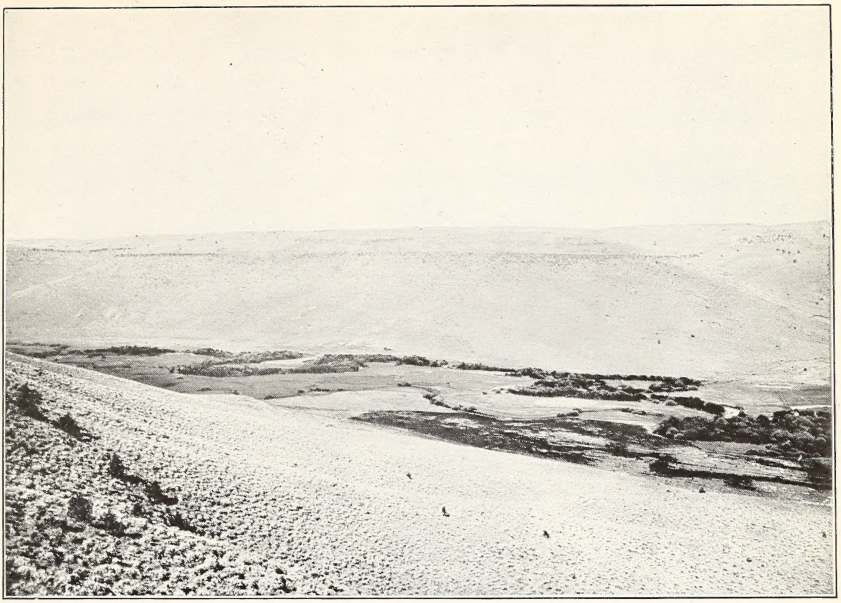

FIG. 1.—A NARROW VALLEY ALONG SILVIES RIVER, BLUE MOUNTAINS, OREGON.

FIG. 2.—A HORSE ROUND-UP, SHOWING THE CAYUSE, THE MENACE OF A LARGE PART OF THE RANGE COUNTRY.

FIG. 1.—AN OVERPASTURED HIGHLAND MEADOW IN THE WASHINGTON WHEAT REGION.

FIG. 2.—AN OVERPASTURED LOWLAND MEADOW, WENAS VALLEY, WASHINGTON.